



Engineers can bring their designs to life in osgBullet, a 3-D simulation where objects look, tumble and collide like the real thing. Virtual prototypes slash the cost and time to develop new equipment.

## INL engineers help develop software for faster, cheaper design and collaboration

By [Sandra Chung](#), INL Research Communications Fellow

If a picture paints a thousand words, a realistic 3-D simulation is worth millions. That's why R&D Magazine recognized the osgBullet software package as one of the most useful new technology products of 2010. The R&D 100 Award-winning software, which Idaho National Laboratory engineers helped develop, can swiftly transform complex 3-D computer models into animated virtual objects that [look, move and interact](#) like the real thing.

osgBullet's developers have demonstrated that their software can cut years of time and millions of dollars from the length and cost of an engineering design project. And osgBullet's availability as a free download at [www.osgbullet.vesuite.org](http://www.osgbullet.vesuite.org) can facilitate collaboration and help put small design businesses on a more level playing field with larger companies. osgBullet generates much of its cost and time savings by allowing engineers to quickly and simply create a virtual prototype that they and their clients can inspect and manipulate at will.

Joe Kleiss and his colleagues at the U.S. Army's Armament Research, Development and Engineering Center (ARDEC) use osgBullet to tweak their designs and gather crucial feedback from clients. Kleiss calculates that virtual prototyping saved an average of \$1.1 million on each of his last 10 design projects and slashed more than two years from the six it usually takes to go from initial design concept to production.

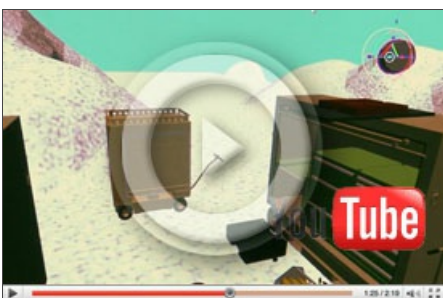
"In the past, you would actually have to make it," says Kleiss, a team leader for ARDEC engineering design projects. "The first time you build a hardware prototype it's never quite right. You may go through that whole process three or four times," racking up expenses and time delays.

With the realistic simulations generated within osgBullet, Kleiss's customers don't need a physical prototype to see what he means. "At key points in our process, both our customer and myself [look at the product](#) and decide, that's the right thing, that's what we want," Kleiss says.

ARDEC and the Department of Energy funded the development of osgBullet. INL engineers Joshua Koch and David Muth worked on the award-winning software with collaborators at [Ames Laboratory](#), [Skew Matrix Software](#), the [National Energy Technology Laboratory](#) and [ARDEC](#).

### Instant movement; just add physics

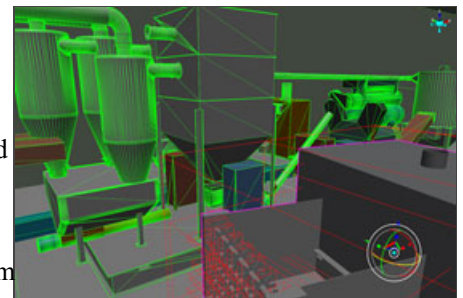
osgBullet marries [OpenSceneGraph](#), a 3-D simulation environment, with [Bullet](#), which applies the laws of physics to simulated objects to generate realistic movement. Several other physics simulations already exist, but none of them work particularly well with 3-D computer-aided design (CAD) models. The highly detailed models can swamp a computer's working memory with the complex calculations needed to accurately describe the models' movement. Stripping away detail makes the simulation run more smoothly, but also less realistically. Designers also have to spend considerable time programming individual models into the simulations.



In contrast, osgBullet imports complex CAD models automatically, and its physics engine can work at varying levels of detail to help minimize the number of necessary calculations.

Koch demonstrates by loading osgBullet and, in less than second, importing a CAD model of a crank wheel. It's essentially a rotating shaft embedded in a knobby barrel that catches and propels other moving parts. When it first appears on the computer screen, the 3-D crank wheel appears to hang in midair, a surreal object without motion or context.

Koch turns on the debug mode, and osgBullet draws thin red lines around the crank wheel to show that the physics engine is treating it as a fat box with two skinny boxes glued to opposite faces. It



*A visualization of the Process Design Unit in action could help developers adjust the machinery to work together more efficiently.*

turns out that's just enough detail to realistically animate the more complex object. Koch clicks "enable physics," and specifies the crank wheel's mass and the strength of gravity. Newton's Laws of Motion instantly kick in: the crank wheel falls to the "ground," bouncing end to end a few times before coming to rest.

Koch is only clicking and dragging a mouse to move simulated objects on a computer screen, but it's hard not to cringe when he picks up the crank wheel and rams it with gusto into the middle of a neatly stacked pyramid of boxes. The targeted box falls backward and forces the boxes above it to topple and jostle the others around and form a convincingly natural mess. Several YouTube [videos](#) highlight these and other capabilities of osgBullet.

It's easy to see how Koch could call up all the parts of a more complex device and assemble them to check for fit and stability. He could look at how several such devices would operate together in a confined space, or how they might crash into each other inside a large container.

Design engineers will eventually be able to use osgBullet to generate a dynamic simulation of complex mechanical systems, such as a manufacturing line on a factory floor. An interactive simulation of a whole power plant or factory could become a training tool that operators use to practice critical repairs and tackle emergency scenarios within the safety of a virtual environment.

### **Visualization: engineering meaning into pictures**

The osgBullet team is currently developing ways to further enrich the visualization with sound and touch information. Users will soon be able to interact with the simulated environment by wearing special gloves that deliver tactile feedback.

"As you reach in and grab that item you're going to get the sensation that you're holding it," Kleiss says.

The technology is still a long way from becoming a real-life version of the "[holodeck](#)," a richly detailed virtual environment that the crew members of the fictional Star Trek Enterprise often used to simulate a vacation from their long, dangerous space mission. But today's computer-based simulations can also improve on reality. They can be designed to illustrate the patterns and meaning in otherwise overwhelming amounts of data.

For example, Koch and Muth want to plug the data from an upcoming test run of the INL Process Demonstration Unit into an osgBullet simulation. The PDU is a modular, portable set of equipment that can be reconfigured to process various biofuel feedstocks for easier transport. PDU test runs will generate extensive data about feedstock moisture, particle size, flow rates and other parameters.

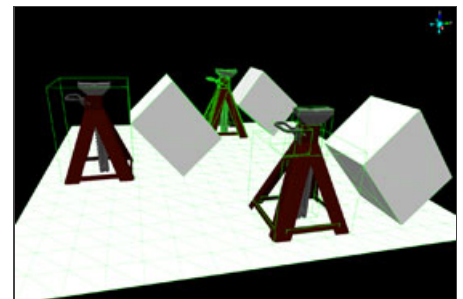
"Data can almost be a hindrance, if you have so much that it's no longer meaningful," Muth says. Integrating the test run data into a visualization could re-create the working PDU in a way that helps engineers better understand what's going on inside the machinery. The visualization can be manipulated in many ways that reality can't: it can run slowly or in reverse, for example, and the user can pause it or zoom in to focus on a single point in time and space.

"It's a lot easier to convey information visually than to talk about it," Koch says. An engineer might be able to tell from crunching the numbers that when the flow of material speeds up, the dryer kiln cools down and the material comes out with more moisture. But seeing the numbers change as the simulated machinery operates can make the meaning of the data more immediately obvious to both engineers and stakeholders.

"We have the potential to provide the medium for the research data to meet the industry people that can make things happen," Muth says.

For the engineers who design everything from spare parts to whole factories, osgBullet takes "see what I mean?" to a whole new level.

[Feature Archive](#)



*osgBullet can simplify 3-D models to varying degrees to change the accuracy and speed of the physics simulation.*